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Pulmonary Function Testing in Aviation Selectees

Naval Aerospace Medical Research Lab.

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718 Aviation Students were divided into four groups and pulmonary function tests results compared among nonsmokers, former smokers, current smokers, and those with pulmonary symptoms. Cigarette smoking did not have any measurable effect on pulmonary functions. Pulmonary functions for the purpose of establishing norms for this age group according to height are summarized.

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Lieutenant Commander Neil R. MacIntyre, MC USNR, and

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SUMMARY PAGE

THE PROBLEM

To establish normal spirometric values for incoming aviation students.

FINDINGS

1. The results of spirometric testing in this student aviator population are generally in agreement with other published reports.

2. Cigarette smoking, even if symptoms were reported, did not have a measurable effect on pulmonary functions.

RECOMMENDATIONS

More sensitive screening tests for early airway dysfunction should be developed and evaluated.

INTRODUCTION

The military aviator is exposed to a number of possible risk factors that could produce pulmonary abnormalities. These factors include breathing 100% oxygen under positive pressure in combination with high G forces and rapidly changing barometric pressures. Little is known about the long-term effects of these stresses on pulmonary functions.

The Naval Aerospace Medical Research Laboratory has instituted a long-term evaluation of pulmonary functions in aviators. This report deals with the first phase of this evaluation, the establishment of normal spirometric values for aviation students.

PROCEDURE

The subjects involved in this study comprised 718 incoming aviation officer candidates at the Naval Air Station, Pensacola, Florida.

Prior to pulmonary testing, information on respiratory illnesses and smoking habits was obtained by a self-administered questionnaire. Specifically, subjects were asked if they had chronic cough; sputum production; shortness of breath; wheeze; current asthma; a history of bronchitis, pneumonia, pleurisy, tuberculosis, silicosis, exposure for long duration to sand blasting, rock dust, coal-mining dust, or any chest surgery or injury. No details were elicited other than a simple "yes" or "no" answer. An affirmative answer to one or more of the questions relating to respiratory symptoms resulted in the questionnaire being marked positive, and the subject was considered to have respiratory symptoms. If the subject gave a negative response to all pertinent questions, he was considered to be asymptomatic. Daily cigarette consumption was obtained as well as the number of years the patient had smoked.

After completing the questionnaire, each subject performed conventional spirometry. This involved forcibly expiring into an Ohio 842 10-liter spirometer while in a standing position. Each subject performed at least three trials and the best trial, i.e., the one with the largest forced vital capacity, was chosen for data analysis. From the forced vital capacity (FVC), the one-second forced expiratory volume (FEV_1), the ratio of FEV_1/FVC, the mid-expiratory flow rate (MEFR), and the mid-maximal expiratory flow rate (MMEFR) were obtained.

The subjects were divided into four categories for convenience of description and comparison: Group I represented nonsmokers free of pulmonary illnesses; Group II were former smokers, i.e., had stopped smoking for at least five months; Group III were current smokers; and Group IV were subjects with any symptom or history of pulmonary illness without regard to cigarette intake. Group I was further subdivided according to height for the specific purpose of establishing norms for this age group.

RESULTS AND DISCUSSION

Mean ages and pulmonary functions for the four groups are shown in Table I. There were no significant differences among groups for any of the pulmonary parameters. Group II averaged five-pack years of smoking and Group III averaged four-pack years.

Pulmonary function data for Group I for the purpose of establishing norms according to height are summarized in Table II.

The results of spirometric testing in this student aviation population are generally in agreement with other published reports (1,2,5,10). Furthermore, cigarette smoking, even if symptoms were reported, did not have a measurable effect on the results. This latter point is in contrast to some studies showing decrease in mid-expiratory flows and vital capacity in the young smoker (6,12-14). In general, however, our results are in agreement with the contention of Kuperman that spirometry is unable to detect abnormalities in subjects with less than a 15-20 pack-year smoking history (7).

In an attempt to find more sensitive screening tests for early airway dysfunction, end-expiratory flow measurements (3,11), helium isoflow techniques (4), and closing volume measurements (9) have been developed. The next step in our program will be the evaluation of these tests on our subjects. But an important question to be asked both in civilian studies as well as in our aviation group is if the new abnormalities detected by this increased sensitivity actually reflects the pathology of pre-clinical disease. The National Heart and Lung Institute's Workshop on Screening Programs for Early Detection of Airway Obstruction has emphasized a lack of understanding of the relationships among asymptomatic pulmonary function test abnormalities, risk factors, and eventual disease (8). Recommendations for mass screening programs were withheld by the Workshop group because of that lack.

It is our hope that, through our future studies with the longer follow-up and more sensitive testing, these relationships, at least as far as aviation risks are concerned, will become clear.

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Table I

Pulmonary Function Measurements
for the Four Subgroups

	Group I (N-438)			Group II (N-70)		
	MEAN	SD	RANGE	MEAN	SD	RANGE
Age (yr.)	23.1	1.8	20-29	23.6	2.2	21-29
Height (in.)	70.9	2.6	64-78	70.3	3.1	57-75
FVC (liters)	5.59	0.75	3.65-8.17	5.23	0.38	4.25-5.89
FEV_1 (liters)	4.54	0.58	3.03-6.55	4.42	0.57	3.17-5.73
FEV_1/FVC (percent)	83.11	6.08	62-96	81.25	6.02	62-95
MEFR-liters/sec.	10.21	1.51	5.92-13.16	10.14	1.43	7.30-12.56
MMEFR-liters/sec.	4.82	1.12	1.83-8.55	4.78	1.08	2.26-7.90
PEAK FLOW-liters/sec.	11.48	1.21	7.53-13.00	11.38	1.18	8.76-12.95

	Group III (N-127)			Group IV (N-83)		
	MEAN	SD	RANGE	MEAN	SD	RANGE
Age (yr.)	23.2	1.9	20-29	23.3	2.0	20-29
Height (in.)	70.4	2.6	55-76	70.5	2.0	64-74
FVC (liters)	5.25	0.35	3.21-6.06	5.25	0.27	4.49-5.84
FEV_1 (liters)	4.53	0.63	3.11-6.20	4.62	0.61	3.11-5.95
FEV_1/FVC (percent)	81.54	6.63	62-97	80.53	6.84	62-94
MEFR-liters/sec.	10.03	1.55	5.18-12.96	10.11	1.51	6.78-13.03
MMEFR-liters/sec.	4.95	1.28	2.23-8.20	4.82	1.25	2.23-8.10
PEAK FLOW-liters/sec.	11.36	1.28	7.67-12.95	11.53	1.15	8.15-12.96

Table II

Pulmonary Function Measurements by Height of Subjects in Group I

Height (in.)	64-66	67-69	70-72	73-75	75
FVC (liters)	4.65 (1.02)*	5.18 (1.06)	5.64 (1.16)	6.09 (1.54)	6.64 (1.02)
FEV_1 (liters)	3.80 (1.00)	4.26 (0.86)	4.58 (0.92)	4.89 (1.10)	5.32 (1.02)
FEV_1/FVC (percent)	81	89	81	81	80
MEFR-liters/sec.	8.90 (2.80)	10.02 (2.76)	10.22 (2.92)	10.58 (3.14)	11.19 (2.47)
MMEFR-liters/sec.	4.00 (2.22)	4.68 (2.12)	4.88 (2.12)	4.92 (2.14)	5.50 (2.46)

*2 SD in parentheses